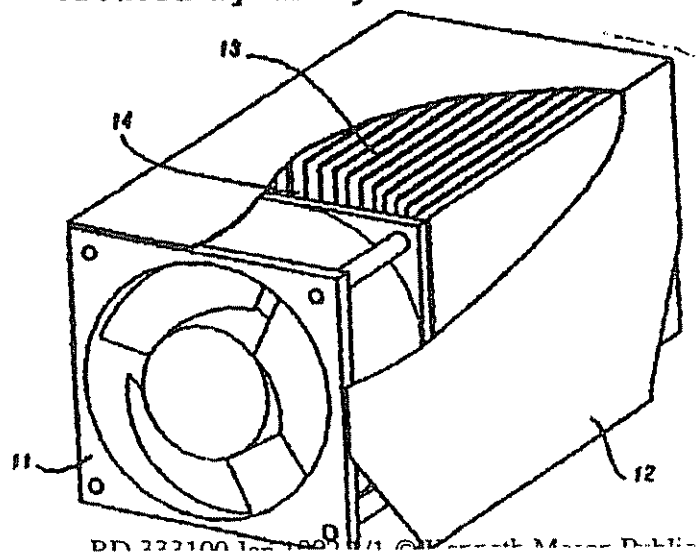
EXHIBIT E

A Heat Sink with Integrated Fans

Disclosed is the structure of a heat sink integrated with a fan. The reason for integrating the heat sink and the fan is to maximize the flow of air and eliminate ducting over those modules which require the greatest cooling. Simply designing the heat sink large enough to provide sufficient passive heat dissipation for high-powered modules can lead to unrealistically large heat sinks.

A cut-away view of the heat sink is shown in the figure. An axial fan 11 is mounted next to a heat sink 13 consisting of many separated parallel thin plates, herein referred to as fins. These fins are constructed of sheet metal, often bent to a particular shape, but may also be constructed by some other means such as by moulding or by NC machining from solid stock. In any case, the fins are attached to, or part of, a base through which heat is conducted away from heat generating elements (such as integrated circuits) that are in intimate thermal contact with the opposite side (from the fins) of the base. Straight fins are preferred since they have the lowest pressure drop, but other fin designs may also be applicable. A duct-like clip 12 covers the fan and the heat sink. It is used for confining the air flow and for mechanical support. For simplicity, the details of the mounting hardware are deleted in the figure. There is an air pressure equalization zone 14 between the fan 11 and the fins of the heat sink 13. This zone is created by placing the "leading" edge of each fin (that faces the pressure equalization zone) some distance away from the fan. This "displacement" distance is a function of position within the array of fins that form the heat sink. The displacement of each fin is tailored such that the amount of air coming out of the fan is distributed evenly among the cooling channels, i.e., the spaces between fins. This is necessary especially when the cooling channels become narrower. More than one fan can be integrated with the heat sink either in parallel or series.

Another version of the implementation of this idea which is not illustrated is to place a fan on top of the heat sink such that air is impinging toward the heat sink and splits into two streams and out from the two ends of the fins. In this version, the equalization zone is created by using different fin heights.



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ATS000706

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Research Disclosure Database Number 333100

Published in January 1992

Research Disclosure Journal, ISSN 0374-4353. © Kenneth Mason Publications Ltd
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